National Aeronautics and
Space Administration

Washington, D.C.
20546

Reply to Attn of: OS

Ms. Donna Searcy
The Secretary
Federal Communications Commission
1919 M Street, N.W.
Washington, DC 20554

Dear Ms. Searcy:

The National Aeronautics and Space Administration hereby submits Reply Comments with respect to the petition for rulemaking by Norris Satellite Communications, Inc., "For Amendment of Parts 2 and 25 of the Commission's Rules to Establish a General Satellite Service in the Ka-band (30/20 GHz)," RM-7511.

Sincerely,

Charles T. Force
Associate Administrator
for Space Operations

Enclosure

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
NORRIS SATELLITE COMMUNICATIONS, INC.	)	RM-7511
	)	
For Amendment of Parts 2 and 25 of the Commission's Rules to Establish a General Satellite Service in the Ka-band (30/20 GHz)	)	

REPLY COMMENTS

The National Aeronautics and Space Administration (NASA) hereby offers its Reply Comments with respect to the petition for rulemaking by Norris Satellite Communications, Inc. (Norris) wherein Norris proposes to allocate frequencies in the Ka-band to a General Satellite Service.

In a separate but related filing, Norris[1] has applied for authority to construct, launch, and operate satellites in the Ka-band. That proposal represents a private commercial venture. NASA does not offer reply comments tendered herein as an endorsement of a specific commercial entity or undertaking. However, NASA does believe that establishment of a General Satellite Service would benefit the United States communications satellite industry as well as the Commission. It is in this context that these reply comments are made.

Comments were submitted by GTE Spacenet Corporation (GTE)[2] in which GTE states opposition to creation of a GSS. NASA believes that GTE's comments were based on a misunderstanding of the potential benefits that a GSS could facilitate and of the effects that a GSS would have on orbit and spectrum efficiency. It is NASA's belief that adoption of a GSS would benefit the United States satellite communications industry and would result in reduced regulatory issues for the Commission to solve while not adversely affecting the efficiency with which the orbit and spectrum can be used. For these reasons, NASA herein submits the following Reply Comments, which it hopes will aid the Commission in its deliberations on establishing a General Satellite Service.

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1. File Nos. 54-DDS-P/L-90 and 55-DDS-P-90.

2. See, GTE Spacenet Corporation Comments filed on November 13, 1990 with respect to RM-7511.

CONCEPT OF THE GENERAL SATELLITE SERVICE

As technology evolves toward digital satellite communications and earth stations become increasingly smaller, allocations based on current satellite service definitions can be seen to be artificial. Such artificial definitions between services may retard development of new frequency bands such as the Ka-band. The development of a new satellite service definition, to be applied to a currently little-used band is important in order to encourage the development of innovative uses of that band on a 8near-term basis.

Adoption of a definition for a General Satellite Service (GSS) and its use in conjunction with specified frequency bands would enable a satellite operator to serve a variety of user terminals, supporting a variety of telecommunications functions, from the same spacecraft and the same frequency band.

There is currently rapid growth in development of new, low to medium rate, digital communications satellite services including the conversion of formerly analog voice services to digital. The user terminals for these services are becoming very small, which is a natural consequence of the evolution of key telecommunications hardware technologies. These new terminals are being used in fixed, mobile, and point to multi-point applications.

In some cases, it is challenging to determine in which service a particular application falls. In other cases, use of a common satellite to provide several services in the same frequency band is thwarted by the limitations of existing allocations. In still other instances, satellite design may be unduly complicated by the need to operate in separate frequency bands in order to provide multiple services from the same satellite. Coordination of satellites providing several services in disparate frequency bands is difficult and orbit/spectrum efficiency can suffer.

The technical and operational problems encountered by multi-function satellites result from a lack of agreed upon sharing criteria for the general satellite service they provide. Such sharing criteria would recognize that permissible use of a given frequency band can be determined by conformance to bounds established by a set of technical parameters rather than by the specific application to be provided.

The concept of the GSS, then, is one where fixed, mobile, and point-to-multipoint transmissions are permitted in a common frequency band. Access to the band would be determined not by the service application of the satellite network but by a set of technical criteria which would insure a level of compatibility between networks. In this way, efficient use of the orbit/spectrum resource can be maintained while accommodating multi-function, multi-service satellites and introduction of innovative new satellite services.

THE SATELLITE COMMUNICATIONS INDUSTRY HAS NOT BEEN WELL SERVED BY THE CURRENT MULTIPLICITY OF RADIO SERVICE DEFINITIONS

The present set of satellite service definitions has resulted in numerous problems for operators and the Commission alike. Narrow service definitions have made it difficult to introduce innovative new services or to accommodate changes in demand from that projected 20 years ago when allocations were initially made. Introduction of some services has developed much more slowly than was anticipated while in other cases new services have been proposed that had not even been identified at the time of the 1971 WARC. One example of too narrow definition of services is the proliferation of mobile-satellites services including maritime, aeronautical, and land mobile-satellite services. The Commission is well acquainted with the difficulties caused by this set of services rather than one generic mobile-satellite service. Other examples of difficulties caused by narrow service definitions can also be cited such as the problems associated with introduction of mobile services and radiodetermination services using fixed satellites, the proliferation of TVROs used for DBS in fixed satellite bands, and proposals to provide broadcasting services via mobile satellites. In fact, space communications is still very new and dynamic and innovative new applications will continue to be developed that do not neatly fit within a set of 20 year old service definitions.

The Commission has an opportunity to take a step toward resolving of the problems resulting from prior excesses in narrow service definitions. Its Industry Advisory Committee (IAC) for the 1992 WARC has recommended[3] that one set of frequency bands, 19.7-20.2 GHz and 29.5-30 GHz, constituting 500 MHz out of 2500 MHz allocated to the FSS at both 20 and 30 GHz,(not all FSS bands above 20 GHz as GTE[4] apparently thinks) be allocated to a General Satellite Service where fixed, mobile, and point-to-multipoint services could be accommodated. The fixed-satellite service would not lose Ka band spectrum as GTE represents but satellite operators would gain great flexibility to aggregate services, including fixed-satellite services, on a common satellite and in a common frequency band. NASA plans to conduct experiments using the ACTS satellite which fall in the domain of fixed-, mobile-, and broadcasting- satellite defined services and can appreciate the flexibility that the satellite communications industry will need to effectively utilize Ka band spectrum. NASA believes that the IAC recommendation to the Commission is a wise one and has recommended in a separate filing that the Commission adopt a proposal for a GSS for submission to the 1992 WARC.

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3. See, Report to the Commission on the 2nd NOI, submitted by the FCC's Industry Advisory Committee.

4. Ibid at 2.

TECHNICAL CHARACTERISTICS OF Ka BAND SATELLITES

The properties of Ka band will have an important bearing on the characteristics of satellites that use the band. Rain attenuation will be larger than at C- and Ku-bands. Multiple satellite spot beams will be widely used. They are easier to implement at Ka band than at lower frequencies and will enable service to earth stations having very small antennas because the satellites will have very high e.i.r.p. The ACTS project at NASA is developing 2.4 m portable antennas that will accommodate Ka band data transmission burst rates of 110 Mbps and 1.2 m antennas for 27.5 Mbps data rates. Multi-beam satellites will allow a high order of frequency reuse, thus multiplying the effective spectrum resource.

NASA believes that the historical trend toward higher power fixed satellites will continue. Combined with the projected use of satellite spot beams, Ka band satellites will likely be quite homogeneous in e.i.r.p.

Earth station antenna gains are also expected to migrate toward a common value at Ka band regardless of the intended application. As noted above, 1.2 and 2.4 m antennas are being developed for fixed-satellite applications. These physically small antennas will have gains of about 46 dB and 52 dB respectively at 20 GHz and 49 dB and 55 dB respectively at 30 GHz. Beamwidth of the smaller of the two antennas at 20 GHz is approximately 0.8 degrees. Antenna discrimination alone would decouple signals from a satellite 2 degrees away by 21 dB compared to the desired signal and from a satellite 3 degrees by 30 dB. Clearly, there is ample opportunity to achieve excellent orbit efficiency with these small antennas. Larger antennas, as might be used for gigabit data rates would only result in even greater earth station antenna discrimination.

Even mobile and personal communications will require earth station antennas with appreciable gain at Ka band because of the effect of higher frequency on antenna effective area. The Jet Propulsion Laboratory is planning to conduct personal communications experiments with ACTS as a precursor to a Personal Access Satellite System (PASS)[5]. A basic personal terminal capable of receiving and transmitting one voice channel will require an antenna with 19 dB gain at 20 GHz and 23 dB gain at 30 GHz.

Antenna discrimination alone is insufficient to permit satellite spacings of 2 to 3 degrees for mobile and personal communications since antenna beamwidths will be on the order of 12 degrees at 30 GHz and 18 degrees at 20 GHz. The latter example requires a separation between satellites of 18 degrees for a discrimination of 15 dB.

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5. M.K. Sue, Editor, Personal Access Satellite System (PASS) Study, Fiscal Year 1989 Results, Jet Propulsion Laboratory Report JPL D-7382.

Several standards could be adopted which would preserve orbit/spectrum efficiency while at the same time maintaining flexibility to accommodate a diverse mix of service applications. A frequency band could be partitioned with a fraction of the band designated for use by systems with earth stations having antenna gain greater than some minimum value such as 20 dB. Spread spectrum modulation would be designated as the modulation of choice in this part of the band. Studies in progress at JPL[6] demonstrate that this arrangement would accommodate orbit reuse by closely spaced satellites. While the maximum capacity available to individual satellites would be reduced when closely spaced, the studies show that total orbit/spectrum utilization would be greater than can be achieved by use of FDMA and the consequent need to separate mobile satellites in orbit by approximately 20 degrees.

Outside the specified partition the minimum earth station antenna gain would be set at a higher value, for example at 46 dB for 20 GHz and 52 dB for 30 GHz. Interference from adjacent satellites would be insignificant in this portion of the band.

While satellites will rely heavily on spot beam satellite antennas at Ka band, there will also be a need for feeder links which employ CONUS wide beams. It might be beneficial to locate these beams in the part of Ka band which is shared by space and terrestrial services since they will be relatively large, fixed in position, and straight forward to coordinate with terrestrial systems.

Use of the simple standards described above would permit closely spaced satellites at Ka band and provide excellent orbit/spectrum efficiency while at the same time accommodating the full range of proposed GSS services (fixed, mobile, and point-to-multipoint) by each satellite.

It is not our purpose here to propose specific standards for the GSS but merely to point out that several sets of standards can be devised which will accommodate a GSS while preserving (even enhancing) orbit/spectrum efficiency. One example has been given based on on-going NASA studies. Other satisfactory standards can also be developed.

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6. M. K. Sue, An Analysis of the Technical Sharing Feasibility of Spread Spectrum Systems, Jet Propulsion Laboratory, in preparation.

COMPARISONS OF GSS AT Ka BAND TO THE 12 GHz BAND ARE NOT VALID

In its comments, GTE[7] cites the Commission decision in 1981 to separate the FSS and BSS allocations at 12 GHz in order to avoid inefficient use of the orbit/spectrum resource. The problem was brought about because at that time there was an appreciable difference in e.i.r.p. between the FSS and the BSS which necessitated large orbital separations between the two to prevent harmful interference. Over the intervening years the characteristics of the two services have become much more similar even at Ku band than they were in 1981. At Ka band, FSS applications and point-to-multipoint applications, as shown above, could be carried out on satellites spaced on the order of 2 degrees apart.

GTE also comments that "DBS orbital spacing policy requires a nine-degree separation between satellites due to the higher power density of DBS spacecraft." We know of no such policy and observe that the Region 2 DBS plan was created without a fixed spacing between satellites. In addition, it was not the higher power density which mandated a minimum separation between DBS satellites which have a common service area. It was the limited earth station antenna discrimination achievable at 12 GHz with the small user antennas that the plan was designed to accommodate.

As GTE states, higher elevation angles will likely be required at Ka band than at lower frequencies because of higher propagation losses. The result will be a smaller orbital arc that can be used for complete CONUS coverage. Since GSS satellites can be spaced as closely in orbit as FSS satellites, as shown above, the likelihood that the usable orbit for CONUS coverage will be reduced compared to Ku- and C-bands is not relevant to consideration of the merits of a GSS. We note though that use of inter satellite links could extend the arc where satellites could be placed while providing full CONUS coverage. Inter satellite links are likely to be increasingly used in the coming years. See, for example, the Motorola proposal for construction of the Iridium satellite system.[8]

For the reasons stated, considerations which applied 10 years ago to the use of the 12 GHz band are not relevant to proposals to establish an allocation for a GSS in a portion of the Ka band.

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7. Ibid at 6.

8. See, Motorola Satellite Communications, Inc. Application for Authority to Construct Launch and Operate a Low Earth Orbit Satellite System in the 1610-1626.5 MHz Band, filed December 3, 1990.

CONCLUSION

NASA is of the opinion that reallocation of a small part of the existing satellite Ka frequency band to a new General Satellite Service would serve the U.S. satellite industry and the Commission well. Access to the newly allocated band should be governed by a set of technical criteria designed to maintain efficient orbit/spectrum utilization. This method for gaining access to the band is in contrast to the present method of determination of access based on the end service to be provided. It could facilitate introduction of innovative new satellite applications and would be a powerful tool to accommodate multi-function, multi-service satellites. It would permit a satellite operator to aggregate services on a single satellite in order to facilitate profitability from expensive investments in space systems.

We fully support the recommendation of the Commission's Industry Advisory Committee for the 1992 WARC that the United States propose international reallocation of the 19.7-20.2 and 29.5-30 GHz bands to the General Satellite Service as defined by the Committee to provide fixed, mobile, and point-to-multipoint services.

We believe that the availability of a General Satellite Service in the United States' Radio Regulations would be a valuable asset for industry and for the Commission alike.

Respectfully submitted,
National Aeronautics and Space Administration

by _____
Charles T. Force
Associate Administrator
for Space Operations (O)

Dated this 7th day of January, 1991